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Original Articles.

THE RATIONALE OF FORCING FLUIDS.

BY GEORGE GILBERT SMITH, M.D., F.A.C.S., BOSTON.

THE forcing of fluids in patients with deficient urinary excretion has shown such striking results, both in the increase in the amount of urine and in the improvement in the general condition of the patient, that it has seemed worth while to gather together certain data bearing on this question, especially in regard to the physiological factors involved.

The "modern theory" of renal secretion, as presented by Cushny in his most excellent monograph on "The Secretion of the Urine,"[1] supposes the secretion to be accomplished by two separate agents—the glomeruli and the convoluted tubules. Each glomerulus, you will recall, receives an afferent branch from the renal artery. This arteriole breaks up into a network of capillaries, which unite again to form an efferent vessel. This efferent vessel breaks up to form a network of capillaries about the tubule, and indeed forms the only blood supply of the latter.

The glomerulus acts solely as a filter; filtration depends upon: (1) the difference of pressure on the two sides of the membrane (blood pressure *vs.* ureter pressure); (2) upon the permeability of the membrane, which may vary from time to time according to various influences, such as lack of oxygen; (3) upon the osmotic pressure of the colloids of the blood serum (Cushny, pages 45-46).

These colloids will not pass through the filter; they hold the other constituents of the blood plasma by an osmotic pressure, equal to about 30 mm. of mercury. A blood pressure of at least 30 mm. is therefore required to separate from the colloids those substances which will pass through the filter. "The greater the concentration of colloid, the less filtrate will be formed at any given capillary pressure" (Cushny, p. 46); in other words, if the blood pressure within the capillaries is greater than the osmotic pressure of the colloids, filtration will take place and a fluid will pass from the capillaries into Bowman's capsule. This fluid is practically identical with the blood plasma minus its colloids or proteins (Cushny, p. 168). It is neutral in reaction and contains water, dextrose, uric acid, urea, sodium, potassium, chloride, Ca and Mg, phosphates and sulphates. The proportions of these substances in the glomerular filtrate, however, are very different from their proportions in the urine.

As the glomerular filtrate — deproteinized plasma, as Cushny calls it — passes down through convoluted tubules, the cells of the tubules reabsorb certain of its constituents. These constituents Cushny divides into threshold and no-threshold bodies; the former are found in the urine only when their proportion in the blood exceeds a certain threshold value, while others are excreted in proportion to their absolute amount in the plasma. Threshold bodies are chloride, sodium and dextrose. No-threshold bodies include urea, foreign bodies (phenolsulphonephthalein), sulphates, phosphates and ammonium. The latter are present in much higher concentration in the urine than in the plasma. Thus urea is excreted in the urine as long as any is in the blood, while dextrose is practically entirely reabsorbed unless the amount in the blood exceeds the threshold value as it does in diabetes. It is evident that, in order to obtain a concentration of a given substance in the urine greater than there was in the blood, a large amount of the water of the filtrate must be reabsorbed in its passage through the tubules. Cushny estimates that normally less than one-third of one per cent. of the amount of water filtered through the glomerulus finally escapes into the ureter.

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* Read before the Surgical Fortnightly Society, Dec. 2, 1920.

So much for the physiology of the kidney; the preceding statements are based upon vast quantities of experimental work and constitute, I believe, the accepted belief of present-day physiologists in regard to the secretion of urine.

In regard to the efficiency of the kidney as a means of ridding the body of waste products, it would appear that the function of filtration is the more important of the two types of renal activity. Reabsorption is necessary, because without it, the kidney would have to withdraw from the blood an altogether impossible quantity of water and of certain essential salts in order to get rid of the waste products. Filtration, however, is the process which actually removes the substances from the blood; reabsorption is secondary to filtration. An increase in the amount of the filtrate, therefore, increases the amount of waste products excreted. This increase is not parallel, but it has been shown by Albarran (Vaquez and Cottet, *Rev. de Med.*, Paris, 1910, xxx, p. 520) that under experimental polyuria, not only is the output of water increased, but the actual amount of urea excreted is increased. In order to increase elimination, therefore, the amount of filtrate must be increased. We have seen that filtration depends upon: (1) the blood pressure; (2) the character of the membrane; (3) the osmotic pressure of the colloids in the blood serum.

Let us first consider the influence which forcing fluids exerts upon filtration by changing the blood pressure. So far as I know, the ingestion of water and the administration of saline solution subcutaneously have no effect upon the blood pressure. In regard to the intravenous injection of saline solutions. Cushny (p. 127) says that "these (experiments) all point to one conclusion—that while the diuresis from the intravenous injection of saline solution is often accompanied by acceleration of the renal blood-flow, this is not by any means always true. Similarly, the arterial pressure sometimes rises, but frequently undergoes no marked change, or may fall during the diuresis. Thus the mechanical factor does not suffice to explain the saline diuresis, though it often coöperates with the chemical changes in the plasma to increase the secretion."

The second factor in filtration is the condition of the filtering membrane. The work upon this phase of the subject seems to be fairly scanty. Cushny (p. 45) speaks of the increased resistance to permeation due to insufficient oxygen, and to "some pathological states." Congestion of the kidneys—the interference with their circulation — depletes the available oxygen and may therefore decrease the permeability of the filter. This point will be brought up later. It seems not unlikely that the production of acid in the tissues of the kidney might decrease the filtration power of the glomeruli. Martin Fischer[2] found that injecting acid into the blood stream of a rabbit produced albuminuria and a decrease in the amount of urine excreted.

The third factor in filtration—the osmotic pressure of the colloids of the blood plasma—has been more thoroughly investigated. The work of Knowlton is interesting. He sought the cause of diuresis after the administration of salines (Knowlton, *J. Physiol.*, London, 1911, xlii, p. 219). Changes produced in the blood by salines are: (1) the lowering of the osmotic pressure of the proteins by dilution; (2) the decrease in the viscosity of the blood. Knowlton, by the injection of Ringer's solution, brought about a diuresis. The addition of gelatine, which is of high osmotic pressure, greatly reduced the diuresis. The blood pressure and the rate of blood flow through the kidney were as great, or greater, during the injection of gelatine. The addition of starch solution, which increases viscosity, but not osmotic pressure, did not inhibit diuresis. Knowlton, therefore, concludes that saline diuresis is due largely to the dilution of colloids. Starling says this dilution of the blood plasma in reducing the colloid concentration increases the amount of the filtrate from the capsule.

To recapitulate: Saline diuresis (or that due to ingestion of large quantities of water) is brought about through a dilution of the colloids of the blood plasma and a consequent lowering of osmotic pressure. The influence of the saline upon the quality of the blood and upon the rate of the blood flow through the kidney, and thereby upon the permeability of the glomerular membrane, may also be an important factor in diuresis.

There are, in practical use, three ways of increasing the fluid content of the body—ingestion into the alimentary tract, subcutaneous injection of the normal saline solution and intravenous injection of the same. Cow (*J. Physiol.*, 1914, xiv, iii, p. 1-17) asserted that water taken by mouth caused greater diuresis than salt solution intravenously or under the skin. He attributed this fact to the diuretic effect of a ferment found in the mucosa of the alimentary tract, and in support of this theory showed experimentally that the intravenous injection of saline containing extract of gastrointestinal mucosa caused a larger and more pronounced diuresis than did the saline alone. This work has been refuted by Hashimoto, who shows that as water is absorbed from the alimentary tract, it takes up salts and then acts on the kidney in the same way as a dilute saline solution injected intravenously.

THE INDICATIONS FOR FORCING FLUIDS.

In Healthy Kidneys: The usual preparation for an operation under general anesthesia has the effect of reducing the fluids of the body quite extensively. A cathartic or even a purge is given, followed by several watery stools. The morning of operation no fluids are allowed except perhaps a few ounces of black coffee. The patient is then etherized, frequently sweats profusely during the anesthesia and vomits afterwards. He is given water very cautiously by his nurse, who fears to let him have all he wants. Under these conditions the blood plasma becomes concentrated and the colloids increase in osmotic pressure, thereby greatly reducing the filtration through the kidney. Not infrequently, especially in children, signs of acidosis appear in the urine. In many cases, the urine contains albumin and casts. These findings bear out Fischer's suggestion, that there is an excess production of acid in the tissues. We have seen that acidity increases the resistance of the glomeruli to filtration; hence the acidosis after etherization is another factor in limiting the ability of the kidney to excrete properly. Consequently, even in a patient with healthy kidneys, we often find the signs of renal insufficiency, *i.e.*, soft distention, dry tongue and nausea. Being nauseated, the patient cannot take water, thereby increasing the symptoms. One subpectoral injection of a liter of normal salt solution will usually suffice to break the vicious circle. It is far better, however, to anticipate the lack of fluids by: (1) forcing fluids until one or two hours before operation; (2) immediately after operation giving either a subpectoral infusion or three pints of tap water by rectum. The latter, if given before the patient comes out of ether, will usually be retained. After that, the Murphy drip may be used or tap water may be given rectally, eight ounces every six hours.

In Damaged Kidneys: If normal kidneys will react in this way to a lack of fluid, how much more seriously affected are damaged kidneys. I refer particularly to the kidneys of urinary retention, whose ability to excrete has been taken away at least temporarily by long-continued back pressure. Cushny (p. 110) says; "In glomerular filtration the capillary pressure is the driving force and if this is taken as 20% lower than the carotid pressure, the difference between the pressure in the capillaries and the maximum ureter pressure, that is, the difference of pressure on the two sides of the capsule, amounts to about 30-50 mm. of mercury. The pressure requisite to force the filtrate through the capsule against the osmotic resistance of the plasma colloids is about 30 mm. of mercury, and the capillary pressure must, therefore, always exceed that within the capsule by this amount." I do not know what the pressure is in an over-distended bladder, but, without doubt, it hinders renal filtration. We know that there is a retention of non-protein nitrogen in the blood of men with chronic urinary obstruction. When the obstruction is removed, the kidneys, if not too seriously damaged, respond by a tremendous diuresis. In other cases, the sudden removal of obstruction is followed by a nearly complete cessation of secretion. It is generally believed that this is due to the congestion of the kidneys, which respond to the sudden decrease in pressure just as the bladder does, that is, by an intense engorgement of the capillaries. Venous congestion, as we have seen, is accompanied by a lack of oxygen and a consequent loss of the permeability of the filtering membrane. There is no other reason for the immediate cessation of renal activity, so far as I can see, for the blood pressure and the colloidal concentration of the blood, which are the other two factors involved in infiltration, are unlikely to change in so short a time. Later, of course, infection may become superimposed upon the congestion, and is, no doubt, a great factor in limiting renal activity. It is not uncommon, however, to see partial anuria set in in a patient whose urine is as yet uninfected, and whose normal temperature makes it seem improbable that a hematogenous invasion of the kidneys has occurred.

In such patients, the inability of the kidneys to function becomes a serious problem. In fact, unless it is met by prompt and efficient measures, the suppression of the urine not infrequently brings about a fatal outcome. The one most efficient method is the forcing of fluids, by mouth, by rectum, or underneath the skin. I recollect one case in which 20 consecutive subpectoral infusions were given before the kidneys became able to carry on their work without such assistance. I have given or seen given literally hundreds of subpectoral infusions, but no abscess has resulted. Even a severe diabetic, who was given salt solution subcutaneously a number of times, showed no evidence of infection of the breasts.

The question will be asked as to how far fluids can be forced without doing harm. With a sound heart and fairly good kidneys, an intake of 200 ounces every 24 hours is not at all excessive. We had a patient who on two consecutive days drank 378 and 376 ounces and whose output on the second day was 463 ounces (3.5 gallons). Fischer states that excessive water drinking causes albuminuria, as it washes out the salt from the tissues. This objection would, of course, be met by the infusion of normal salt solution.

As prostatic obstruction occurs chiefly in men of advanced years, it is not surprising that many of those who come to operation for this trouble have arteriosclerotic hearts. The medical consultant who sees these cases often advises limiting the fluid intake. My experience has led me to believe that this should not be done unless the patient has oedema. Fischer suggests that limiting the fluid intake in cardiac decompensation is a relic of the belief that the urinary secretion is brought about by the pushing of the water through the kidney by the heart. He believes that increasing the fluid intake by reducing the viscosity of the blood, really lessens the work of the heart[2] (p. 131).

There is much need for further investigation of the physiological chemistry of the body after operation, and in cases of renal insufficiency. The question as to how great a part acidosis plays in these conditions is important and, so far as I know, it is as yet unanswered.* Of the value of forced fluids in the above situations, there can be no doubt. The elimination of waste products through the kidneys depends upon filtration; filtration depends upon (1) the condition of the filtering membrane; (2) the dilution of the colloids of the blood plasma. Both of these conditions are influenced favorably by increasing the fluid content of the blood.

REFERENCES.

[1] Cushing, A. R.: The Secretion of the Urine. 1917. Longmans, Green & Co.
[2] Fischer, Martin: Nephritis. 1912. John Wiley & Sons.

STRANGULATED HERNIA IN THE AGED. LOCAL ANESTHESIA. CASE REPORTS.

By Martin T. Field, M.D., F.A.C.S., Salem, Mass.

After many years of wear and tear and histological changes due to advancing age, anatomic defects become more pronounced. These defects are aggravated by bronchitis and other afflictions common at this time of life. It is not surprising, therefore, that strangulated hernia is a potential danger always present in the aged.

Unless we are watchful, it is an easy matter to overlook a small strangulated hernia and diagnose the symptoms as those of some gastrointestinal or other disturbance common in old people. A positive diagnosis established, the method of relief is then of vital importance.

Operation for strangulated hernia under local anesthesia, is one of the good things in surgery that cannot be too highly recommended. It, at once, eliminates many of the dangers which make other types of acute intestinal obstruction, under a general anesthetic, yield such a high mortality.

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* This question is now under investigation by Shedden, Resident Surgeon on the Genito-Urinary Service, Massachusetts General Hospital.

Statistics from the larger hospitals, show that the mortality incident to acute intestinal obstruction, excluding strangulated hernia, has not been greatly reduced the last ten or fifteen years. Fortunately, the operative mortality of strangulated hernia has shown much greater improvement.

The factors that have brought about this are:

Earlier recognition;

Less manipulation of the hernia mass.

Operation under local anesthesia.

Every patient suffering acute abdominal pain with or without vomiting or constipation, should have the inguinal and femoral rings examined to ascertain the possibility of strangulation. Neglect of this precaution leads to humiliating and disastrous results. The diagnosis of hernia made, it is brutal and injurious to use much force in the effort to reduce a hernia that is often reduced only with difficulty with the parts wide open.

Local anesthesia is particularly suitable in the treatment of strangulated hernia, unlike many other types of acute intestinal obstruction. The point of obstruction is at once known without searching for it. There is required a minimum amount of traction on the abdominal wall and mesentery and the parts are readily accessible.

The technique used in these cases (common types) is briefly as follows:—

Inguinal hernia.

Infiltration of skin and subcutaneous tissues along line of usual incision with 0.5 per cent. novocain, then the needle is plunged straight down until it overcomes the resistance of the external oblique aponeurosis. About one-half ounce of solution is deposited beneath this structure in the position of the ilioinnguinal nerve. A little is also injected in the region of the external ring. After waiting a few minutes the incision is then carried down to the external oblique. This structure is carefully opened near the internal ring and the flaps raised, exposing the ilioinguinal nerve which lies on the internal oblique muscle. The nerve is at once blocked by injecting a small amount of solution into it, which immediately turns white.

This nerve controls nearly nine-tenths of the sensation of this region. The aponeurosis is now cut down through the external ring and also above the internal ring, exposing iliohypogastric nerve which is also blocked. This nerve lies above the arching fibres of internal oblique above the ileoinguinal and parallel with it. Both these nerves lie beneath the external oblique lying upon the internal oblique and run from without inward. They control all the sensation except that of the genital branch of the genitocrural, which lies in the posterior part of the cord and can be blocked later on or as is usually the case, a small amount of solution can be injected about the upper part of the cord which accomplishes the same result. Care must be taken not to puncture any veins. No more novocain is required except when sac is tied; a little novocain is then injected to render the parietal peritoneum insensitive.

The radical operation is now performed, either with or without removal of the testicle. In old men, especially, with recurrent hernia, removal of testicle helps to prevent recurrence. Removal was carried out in Cases 3, 4 and 5.

There may be some anomaly of nerve distribution, but usually the ilioinguinal, iliohypogastric and genital branch of the genito-crural are found in the position cited. If these are blocked, there will be no pain.

Femoral Hernia. This type of hernia must be treated differently from preceding. The technique is simpler. There are so many nerve branches coming into this region from all sides that it is necessary to use the infiltration method. The skin is injected along line of incision, which is a vertical one, the subcutaneous tissues and tissues about the sac are also injected. The fat is separated from sac. Gimbernat's ligament must be either cut or stretched with small retractor. It is rarely necessary to cut Poupart's ligament unless hernia is very large. If cut, it must be repaired later. This ligament had to be divided in Case 1.

The neck of sac is freed carefully from surrounding tissues by finger or retractor. There is usually fluid between intestine and sac; occasionally there is not (Case 7). There was not a drop of fluid in this sac and I do not believe any escaped into the abdominal cavity. The black bowel and sac wall were in close contact. I mention this as an exception to the rule that fluid is present between bowel and sac-wall. Much care must therefore be exercised in opening sac, not to injure the intestine.

When Gimbernat's ligament has been cut or stretched and the tissues about the neck of the sac freed, the hernia can be generally reduced. Occasionally this cannot be accomplished, as in Case 8, because of the constriction of the thickened sac itself. It is then necessary to introduce a hernia knife between gut and sac and cut constriction.

It is well to draw out bowel beyond constriction and inspect it. If it is reduced first, it will be sometimes difficult and dangerous to pull out a diseased segment of bowel from within abdominal cavity through small opening. Hot salt pads are applied until the circulation returns, taking as much time as is needed. The bowel is insensitive to pain; it can be cut or burned without causing discomfort. Traction on mesentery, however, will cause pain. After injecting a little solution about the neck of sac, it is tied off and resected, first transfixing it. It is allowed to retract within the abdominal cavity and Poupart's ligament is sutured to pectineus muscle and fascia, including in the bite of the needle all tissues down to the periosteum of the pubis bone. The femoral vein is retracted very carefully when first or external stitch is introduced. Two or three other interrupted sutures, internal to this as far as the pubic spine can then be easily put in.

The wound is closed without drainage. My own experience leads me to believe that this type of operation is simpler and safer in these old people than the inguinal operation for femoral hernia, as advocated by Seelig and Tuholski and others.

The following cases illustrate the value of this technique:

Case 1. Mrs. N., aged 73 years. Strangulated femoral hernia, three days' duration, constant abdominal pain and distention, persistent vomiting, very foul. Operation August 7, 1917, local anesthesia. Large coil of strangulated small intestine, very dark, reduced with difficulty. It was found necessary to cut Poupart's ligament, before reduction was possible. Radical cure, convalescence was complicated by pneumonia. Left the hospital well August 16, 1917.

Case 2. Mrs. K. B., aged 70 years. One week prior to this she was operated upon by another surgeon for strangulated femoral hernia. Incision was made and the mass reduced. There was no relief, and vomiting and pain continued throughout whole week; vomitus fecal; no mass to be felt at ring. Operation, local anesthesia, October 17, 1918. Right rectus incision, small intestine found obstructed at femoral ring. It was evident that at previous operation sac and all had been simply reduced without relieving strangulation. The obstruction was released with much difficulty. I thought it was best to take a chance and not resect, in view of serious condition. Repair of hernia was also done. Convalescence uneventful. One year later returned to hospital for relief of stomach symptoms; inoperable cancer of pylorus found; gastroenterostomy done. Left hospital in two weeks improved. Now dead.

Case 3. Mr. H., aged 83 years. Strangulated inguinal hernia, forty-eight hours' duration, abdominal pain, distention and vomiting. Operation July 9, 1919, local anesthesia. Large mass on left side, irreducible; found to be large sliding hernia of sigmoid. Further search disclosed a small coil of small intestine strangulated in lower part of canal (direct hernia). Color returned after hot applications were applied. Sac resected. This and sliding hernia were repaired as well as possible. Testicle removed so that better repair could be made. Patient was delirious for several days; cough troublesome. Left hospital well July 24, 1919. Is now in good health.

Case 4. Mr. C, aged 71 years. Strangulated inguinal hernia (right oblique). Two years prior to this, was operated upon for strangulation, followed by recurrence. Present attack began about six hours before operation. Abdominal pain and vomiting. Operation, December 11, 1919, local anesthesia. Large hernia, small intestine strangulated. Color returned after hot applications were applied. Radical cure after removal of testicle. Patient left hospital December 28, 1919. The last time seen, several months after operation, was well.

Case 5. Mr. R., aged 77 years. Strangulated inguinal hernia (right oblique). Operation, June 27, 1920, local anesthesia. Large sac resected, radical cure after removal of testicle. Left hospital July 11, 1920. Has since been well.

Case 6. Miss O'C., aged 86 years. Strangulated right femoral hernia, four days' duration. Abdominal pain, distention, and vomiting. Loops of distended bowel evident. The day of the operation, vomitus distinctly fecal. Operation September 4, 1920, local anesthesia. Intestine reduced with difficulty, color did not return very well. Thought better to take a chance and not resect. Convalescence uneventful. Left hospital September 19, 1920. Has since been well.

Case 7. Mrs. F., aged 90 years. Strangulated right femoral hernia; sick for three days. Pain, vomiting and prostration cause of severe pulmonary symptoms. Her trouble was first thought to be pneumonia. Later, small irreducible mass was discovered. Patient in very poor condition and family objected strongly to operation, believing that she would surely die. Operation

September 27, 1920, local anesthesia. Small coil of very dark bowel liberated and reduced; no fluid in sac. Sac wall and intestine in contact. Radical cure. Left the hospital in good condition after four days, October 1, 1920. She has since been well, except for the bronchitis and other infirmities she has had for years.

CASE 8. Mr. B., aged 67 years. Strangulated left femoral hernia, eleven hours' duration. Abdominal pain, vomiting and some distention present. Operation, October 4, 1920, local anesthesia. Fair-sized hernia mass. Gimbernat's ligament cut and tissue freed about neck of sac. Sac opened. Intestine very dark; impossible to reduce it, even though finger could be passed about neck of sac. It was necessary to insert hernia knife within sac and cut thick constricting neck. Radical cure. Convalescence uneventful. Left hospital well, October 19, 1920.

Gastric lavage was done in nearly all the patients.

This report, covering a three-year period, does not include ether patients or those under 65 years of age. Some strangulated cases, old and young, were given ether for one reason or another; but all of these were good risks and vomiting was not a prominent factor. I believe, however, that the margin of safety was narrowed considerably by giving these patients general anesthesia.

The only cases reported in this list are those well advanced in years and done under local anesthesia. The ages are from 67 to 90 years, the average age being 77 years. These are not picked, but consecutive cases, operated upon in this way because of poor risk. All these patients recovered, a result, I am sure, that could not have been obtained with general anesthesia. In looking back over my experience during a period of ten years of ether, I can recall three operative deaths and two of these were no worse than some of the cases reported. This is my excuse for publishing this report.

In conclusion, it seems logical to state that every patient with strangulated hernia should be given the chance to live, which operation alone can give, no matter how old or debilitated or how long the strangulation has existed (cases 6 and 7).

Resection of the bowel should not be performed unless there is urgent need of it. Statistics show that nearly all these primary resections and repair cases, especially in old people, die. If the bowel is hopelessly diseased, it is ordinarily better to drain and repair later. In some of these cases reported, there was considerable doubt as to the viability of the bowel; yet, in all these cases, convalescence was uneventful.

On the other hand, the operative mortality of simple hernia in the young adult, under general anesthesia is practically *nil*. In these cases, there is no serious objection to ether. In old and debilitated patients, there is considerable objection. In the presence of strangulation, especially in the aged, local anesthesia is imperative.

SIGNIFICANT REACTIONS OF THE ARTERIAL TENSION, MANIFESTATIONS OF THE ANGIO-KINETIC ENERGY, CLINICALLY OBSERVED AND INTERPRETED.*

BY CLAËS JULIUS ENEBUSKE, M.D., PH.D.,

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SINCE the publication of my article on the "Normal Arterial Tension in the BOSTON MEDICAL AND SURGICAL JOURNAL, March 6, 1919, questions in relation to the radialis maximum tension have been repeatedly addressed to the author, questions which cannot be answered by snapshot remarks. In view of the importance and complexity of the subject, my answers, written as briefly as is consistent with adequacy and lucidity, have taken form of the series of chapters which will be here presented in logical sequence.

For the conception, clinical observation, formulation and interpretation of the several biological tests—angiokinetic reflex tests as well as biochemical—made use of in my investigations and described in this communication and in my earlier publications, I am responsible, personally. Conversely, references made, especially in Chapter III, to such physiological mechanisms as are known through laboratory investigations previously made, have been drawn from standard physiological literature, particularly from textbooks and monographs by the authors indicated in the list of literature at the end of Chapter IV (1-15).

I. IDENTITY OF RADIALIS MAXIMUM TENSION.

In the present paper the author will endeavor in some measure to elucidate the particular identity, nature and significance of the radialis maximum tension, and of certain reactions of

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* Received for publication October 28, 1920.

the arterial tension which are observable and measurable at the radialis and also to exemplify the practical value of the study of these reactions, particularly with reference to neurology and psychiatry, and also general medicine. For this purpose, certain reactions of the arterial tension will be described, which frequently are associated with various psycho-neurological symptoms and not rarely connected with phenomena, popularly denominated "spells," fainting spells or others.

The present paper is not devoted to expostulation of any technical details. It is written because the facts observed and herein discussed emphasize the advantage of objectivity of observation and interpretation and also objectivity in the practical application of findings. Here is not the place for description of various instruments and their uses. Such knowledge must be acquired by practice in teaching-institutions. It cannot properly be given in a discussion of interpretation and clinical application lest the description be either incomplete and thus possibly misleading, or else blocking in its effect upon the presentation of the scientific subject under consideration. Therefore, it must suffice here to say that from a scientific point of view, the only essential requirement of an instrument for the measurement of the radialis maximum tension, *i.e.*, a "radialis-arteriotonometer," is that it must be so constructed that the artery is to be compressed by means of a small pelotte, *i.e.*, of about the size equal to the palpation surface of the examiner's index finger. Reasons for this requirement will appear on subsequent pages. Beyond that, additional instrumental devices necessary for measuring and recording the amount of pressure used for obliteration of the pulse-wave may vary within very wide limits and all be acceptable. Any reference made in this paper to different methods is made only for the purpose of attaining an adequate clinical-physiological interpretation of the identity, nature and significance of the findings obtained, no matter which kind of instrument may be used.

When performing the measurement, the examiner must perceive the difference between the sensation conveyed through his touch by the pulse-wave passing through beneath his finger and the sensation of the pulse obliterated by the counter pressure of the instrument upon the artery. He must perceive exactly that moment of time when, at a slowly increasing pressure of the instrument, the *next* arriving pulse-wave, *even at the moment of time at which it reaches its maximal tension,* cannot overcome the counter pressure upon the artery. At just that moment of time he must read the amount of pressure employed. The value read is the *identical radialis maximum tension, i.e., the amount of pressure which is the smallest counter pressure upon the artery which the pulse-wave at the moment of its maximal tension cannot overcome.*

The radialis maximum tension, in its physiological normality, as well as in numerous pathological states, has been the object of the author's study and observation since the year 1904. Such observations constitute the material of facts upon which the present inquiry is based. More than 40,000—approaching 50,000—such measurements have been made and studied by the author during the intervening years. It may not be amiss here to emphasize the fact that the anatomical point at which these observations and measurements are focussed is invariably the same. It is precisely the point above the wrist-joint, at which the pulsations of the radialis artery are visible and palpable as most superficial. This is identically the classical point at which the routine examination of the pulse, the "feeling of the pulse," is made by every physician in all lands, as has been done by generations of physicians before, throughout a long line of centuries at the historical dawn of which, more than 4,500 years ago, the ancient physicians of the Far East, appear to have already acquired a skill of performance and a profundity of interpretation in comparison with which subsequent observations, even down to our age, bear the mark of more or less superficiality.

A book on the "Ancient Art of Feeling the Pulse," written 4,506 years ago by an Emperor of the Far East, is the oldest book in reference to the subject, of which the author has found mention in the literature. Much to his regret, the author has not succeeded in finding the name of the Emperor-author, nor of the shrine into whose keeping the precious volume is entrusted, much less found opportunity to deepen his insight in matters pertaining to the pulse through a pilgrimage to this most ancient spring of angio-kinetic information.

II. VASCULAR PRESSOR AND DEPRESSOR REACTIONS.

The *theory of vasomotility*, which is a summation of the brilliant achievements in this field of laboratory physiology from the fundamental discoveries of vasoconstriction and vasodilation (1851-1858, Claude Bernard, Brown-Séquard and Schiff), and of the vasomotor centre in the bulb (1864, Ludwig-Thiry) to the present time—is built upon elementary facts acquired by ingenious and painstaking experiments upon animals. The nature of these experimental methods precludes unavoidably their direct transplantation to the field of clinical investigation, made up as they are, in the main, by observing the immediate and subsequent effects of dividing the nerves to various organs and of electric excitation of the central and peripheral ends of the cut nerve, also by direct electric excitation of various organs. Other stimuli than electric occur, although with lesser prominence. When effects of chemical substances, introduced per os or in the blood, are investigated, canules inserted into the cut ends of carotid or other artery transfer the pressure effects on the blood upon recording instruments of various devices. Thus the effect of the chemical excitant is complicated by the effect of the psychic and trauma-shock upon the animal, and also by the effect upon the vasomotility produced by the narcotic employed for anesthetic purpose. Briefly: the end result of the experiment is considerably complicated, besides the nature of the experiment precluding its transplantation to the clinical field. Considering the brilliancy of achievement and the wealth of result in this most important department of the history of medical science, one cannot but feel that clinical methods of investigation have not as yet attained a development commensurate with the importance of the subject. In consequence, the compass of learning possessed by experimental physiology has not in clinical medicine condensed an application which adequately confirms or demonstrates the practical significance of the present physiological theory of vasomotility.

This being so, and considering the distinctive character of the radialis maximum tension as formulated in preceding chapter and further interpreted and demonstrated in subsequent chapters, the author of this inquiry has felt induced to endeavor to utilize the radialis maximum tension as basic value for comparison of the magnitudes and clinical character of vascular reflexes under physiological conditions and in morbid states. In order to facilitate the fullest comprehension of this chapter, the author begs to anticipate at this point the information which will be argued and proven in subsequent chapters, *viz.*, that the changes in the radialis maximum tension give a direct numerical expression of the angio-kinetic activity in the circulatory periphery and that in this aspect as well as in others which will be proven later, it is of different identity than the so-called blood-pressure, as clinically determined at present, and that these two differing identities are dominated by entirely different mechanisms leading to values which are incommensurable, the one with the other. The one cannot be computed from the other as known; both of them are important and valuable but of different clinical significance.

Many variations of procedure are imaginable whereby reflex reactions of the arterial tension may be obtained and observed clinically. In view of the continuous expansion of the armamentarium of tests for diagnostic purpose which is an unavoidable sequence of the tendencies in present evolution of medicine, it is obviously important in the selection of any method of clinical examination to take under consideration in how far the time consumed by making the test, is favorably balanced by the exactitude of the findings, the certitude of their interpretation and the value of the result with reference to diagnosis, prognosis and formulation of therapeutic indications.

In order to obtain a rapid orientation in the state of the arterial tension, the author has frequently made use of the following manner of proceeding: for examination, the patient (when not otherwise indicated) is seated in a chair, in a restful position, with arms supported in a manner to secure passivity to the muscles. It goes without saying that by constantly making use of the same chair, with or without special construction for the purpose, the patient and the examiner every time assuming the same attitude, etc., something may be gained in favor of uniformity of results. This is not necessary. By much practise the individual examiner makes himself completely independent of external rules in the measure as he acquires adequate visualization of the physiological mechanisms involved in the proceeding and of any incidental complication that might present itself.

Only one rule is indispensable. In the examination room, quiet and order must prevail without the necessity of disciplinary supervision and effort from the part of the examiner. The patient must be undisturbed in his passivity, and the examiner must be left undisturbed in focussing his attention upon the examination.

With the above general considerations in mind, the following four tests, *a-d,* are made, the one after the other without interrogation or intervening delay, as all four together constitute one complex test:

a. Examine the radialis maximum tension on the patient s right arm and note its zipher value.

b. A few light strokes are made with the examiner's hand over the skin of the right side of the patient's neck, three or four strokes up and down from the level of the ear to the middle of the shoulder, merely touching the skin, without exercising any pressure. As soon as it is done, renewed measurement of radialis maximum tension of right arm is made and value *b* noted.

c. Take up a small fold of the skin of the same area on the right side of the patient's neck and pinch it sharply for a brief moment between the nails of the examiner's first and second finger. This done, the examiner makes a renewed measurement of the radialis maximum tension of the right arm, and the value *c* is noted.

d. With the second finger of his right hand, the examiner applies a sharp pressure over the patient's right ulnar nerve at the dorsal side of the elbow where the nerve is exposed superficially under the skin and subcutaneous tissue, forcing it between the tip of his finger and the underlying epicondyle of ulnaris—a snapping, short, sharp pinch. This done, renewed measurement of the radialis maximum of the right arm is again made, and the value found, *d* is noted.

Thus four values of the radialis maximum tension of the right arm have been obtained. It is important in the tests, *b, c,* and *d* that the renewed reading of the radialis maximum should be made at about 15 seconds after the preceding mechanical stimulus has been applied. In some cases 20 seconds after mechanical stimulus is too late, in other cases a delay of several minutes would not impair the test. It is important that the pinch of the ulnar nerve should not be harmful. There is much experience in support of the assumption that, properly done, it is harmless.

The result of these four tests vary within very wide limits, in one and the same individual at different states of the disease, or even without apparent change in the state of the disease, they may vary in the same individual during the same day, under various influences, ordinarily not controlled, but *capable of being controlled* when their mechanisms and significance is understood. As examples of concrete cases and for the purpose of an introductory discussion of the mechanism and the significance of these tests, the results of a few examinations recently made by the author in the Department of Nerve and Mental Diseases, Boston Dispensary, are found in appended Table I.

Except when indicated otherwise (No. 12) the cases referred to in Table I are patients who have consulted the Department of Nerve and Mental Diseases of the Boston Dispensary on the dates indicated in the table. The cases are not selected for Table I in any other sense than that one example or two of each of the basic (test *a*) radialis maximum values as observed, from 70 mm. to 320 mm., have been arranged in order of ascending value from the lowest to the highest. The cases represent the average of the class of cases that form the majority of visitors to the clinic. It will be further explained that one case on the table (No. 12) is exceptional and represents the normal radialis maximum tension; all the others are more or less pathological.

Values lower than 70 mm. and higher than 320 mm., have been observed by the author, but they are omitted from Table I on account of the difficulties connected with their measurement. Between 70 and 320 mm., the measurements are reliable. The remark must be made, however, that below 100 mm. and above 280 mm. Hg., there is increasingly greater difficulty in reading the exact value, a difficulty which is vanquished by continuous practice. In 26 of the cases on Table I, all the four tests, *a-d,* have been made. If, in these 26 cases, we compare the several values, *b, c* and *d,* on the one

TABLE I.

No.	NAME	OCCUPATION	AGE	DIAGNOSIS	DATE	RADIALIS MAXIMUM TENSION IN MILLIMETERS a	b	c	d	lability
1	S. W.	boy	4	Hypophrenosis	9, 8, '20	70	?	?	?	
2	G. S.	boy	10	"	10, 1, '20	80	?	?	?	
3	E. W.	girl	5½	"	4, 16, '20	90	100	110	?	
4	W. B.	boy	7½	"	4, 6, '20	100	90	90	70	—30
5	M. L.	girl	14	"	6, 22, '20	100	100	100	90	—10
6	M. C.	girl	10	"	4, 16, '20	110	120	130	90	—20, 40
7	D. W.	girl	8	Epilepsy	4, 13, '20	110	120	140	90	—20, 50
8	A. W.	girl	17	Hypophrenosis	7, 4, '20	120	130	130	100	—20, 30
9	G. K.	wife	35	Epilepsy	9, 8, '20	100	100	100	80	—20
10	H. T.	wife	48	Psychoneurosis	7, 30, '20	130	130	130	120	—10
11	F. P.	boy	6	Old Poliomyelitis	10, 8, '20	130	?	?	?	
12	A. P.	laborer	45	Formerly Asthma*		150	150	150	150	±0
13	A. H.	wife	56	Neurasthenia	5, 14, '20	150	180	180	130	—20, 50
14	K. H.	girl	13	Pinworms	9, 14, '20	160	160	160	100	—60
15	L. T.	girl	20	Psychoneurosis	6, 25, '20	170	190	190	130	—40, 60
16	L. O.	clerk	26	Epilepsy	9, 8, '20	180	210	230	150	—30, 80
17	J. C.	girl	15	Chorea	8, 27, '20	190	210	210	110	—80, 100
18	M. P.	housework	51	Epilepsy, psychosis	4, 16, '20	200	210	230	130	—70, 100
19	B. D.	wife	54	Psychoneurosis	4, 16, '20	210	230	250	150	—60, 100
20	J. G.	wife	54	Psychoneurosis	4, 16, '20	220	260	280	200	—20, 80
21	M. B.	vender	32	Chorea (influenza)	6, 1, '20	230	240	210	160	—70, 80
22	H. C.	wife	68	Insomnia	9, 8, '20	240	230	220	180	—60
23	M. B.	housework	55	Menopause	6, 15, '20	250	270	290	210	—40, 80
24	E. B.	wife	70	Neuritis	9, 8, '20	260	260	260	200	—60
25	J. P.	carpenter	33	Traumat. Neurosis	7, 15, 20	270	270	280	230	—40, 50
26	C. S.	night boss	33	Psychopathosis	1, 27, '20	280	280	310	200	—80, 110
27	K. F.	wife	55	Menopause, hysteriform	9, 14, '20	290	290	320	180	—110,140
28	K. F.	wife	55	Menopause, hysteriform	7, 23, '20	300	280	270	190	—110
29	A. M.	tailor	70	Occupation Neurosis	9, 17, '20	310	290	320	250	—60, 70
30	M. C.	nurse	64	Traumat. Neurosis	9, 21, '20	320	320	320	240	—80

* Private case.

hand, with the basic value of test *a* on the other, the relation will be found as here summarized.

1. Test *b* value is lower than basic value *a* in 4 cases out of 26
   " *b* " " equal to " " *a* " 10 " " " 26
   " *b* " " higher than " " *a* " 12 " " " 26
2. Test *c* value is lower than basic value *a* in 4 cases out of 26
   " *c* " " equal to " " *a* " 6 " " " 26
   " *c* " " higher than " " *a* " 16 " " " 26
3. Test *d* value is lower than basic value *a* in 25 cases out of 26
   " *d* " " equal to " " *a* " 1 case " " 26
   " *d* " " higher than " " *a* " 0 case
4. In the 4 cases where test *b* value is lower than basic value *a* the difference is 10–20 mm.
   In the 12 cases where test *b* value is higher than basic value *a* the difference is 10–40 mm.
5. In the 4 cases where test *c* value is lower than basic value *a* the difference is 10–30 mm.
   In the 16 cases where test *c* value is higher than basic value *a* the difference is 10–60 mm.
6. In the 25 cases where test *d* value is lower than basic value *a* the difference is 10–110 mm.

Briefly: Tests *b* and *c* cause *increase* of radialis maximum tension in a majority of the cases. Test *d* causes *decrease* of radialis maximum tension in all cases but one (No. 12)..

The result thus itemized may now be formulated in the following terms:

1. Afferent mechanical excitation applied to the skin at the side of the neck below the level of the ear and above acromion causes in more than one-half of the cases submitted to the test *a, reflex pressor effect measurable at radialis,* which pressor effect is more marked at a relatively higher intensity of the stimulus than at a lower (more marked by pinching than superficial stroking).

2. Afferent mechanical excitation applied to the ulnar nerve trunk causes in all or nearly all cases a *reflex depressor effect measurable at radialis,* which effect varies between 10 mm. and 110 mm. Hg. in the cases tested, and in the majority amounts to 30 mm. or more. In four cases out of 26 depressor reaction followed an excitation the like of which produced pressor effect in the majority of the cases tested. Why?

III. PHYSIOLOGICAL MECHANISMS RELEVANT TO VASCULAR REFLEX REACTIONS.

In tests *b* and *c,* mechanical excitation of an area of the skin at the side of the neck deriving innervation from third and fourth segments of the cervical spinal marrow produces *reflex pressor reaction* in a majority of the cases. (An analogous experimental reaction—not considering here the effect of pressure from neoplasms, etc., upon the cervical sympathetic—is known from neurological experience in the fact that pain evoked through faradization applied to the neck causes dilatation of the pupil. This reaction is explained as starting from unknown cortical centres of pain, thence proceeding along associative paths over centrum ciliospinale in eighth segment of cervical spinal marrow, through ganglion cervicale supremum of the sympathetic system to the musculus dilator pupillae.)

The mechanisms known through experimental physiology which are principally applied in the present interpretation of the clinical angiokinetic reflex tests, may be briefly summed up as follows (1-15).

Vascular tonus is reflexly influenced by any sensory nerve. Stimulation of afferent nerves is transmitted by either vasoconstrictors or vasodilators, or both. Whether pressor or depressor effect results, depends upon predominance of the one of the other. Schematically speaking, and without considering intermediate neuronic elements, the afferent nerves engaged in tests *b*, *c* and *d*, enter the spinal marrow through the posterior roots of the spinal nerves and following the posterior columns in the cord transmit the stimuli to the vasomotor centre in the bulb (Ludwig-Thiry's centre). Here the afferent influence received is transformed into efferent influence which is transmitted from the bulb through vasomotor fibres running in the lateral bundles (mostly) of the cord, leaving the cord through the anterior roots of the spinal nerves (even posterior roots of fourth and fifth lumbar nerves contain vasomotor fibres of depressor function), thence by way of rami communicantes proceeding to the ganglion sympathetic system, whence branches go either directly to follow vessels or first unite with ramifications of the various plexuses from which branches lead to all vascular areas of the various organs. In the vessel walls the terminal ramifications of the vasomotor nerves are seen surrounding the smooth muscle cells in the tunica media forming a delicate network containing abundant minute ganglia. Depressor nerves are less demonstrated than constrictors but assumed to follow the paths of the latter. What kind of vasomotor-reflex action results from an afferent influence thus transformed into efferent influence in the bulb depends upon the (a) different kind and intensity of the stimulus, the (b) different anatomical structure upon which the stimulus is applied, and (c) the different state of the cardio-vascular tonus at the time previous to the stimulation. Electric excitation of the skin generally causes reflex pressor effect, which, as far as known, is usually and chiefly the result of vasoconstrictor stimulus through the splanchnic system of the abdominal sympatheticus affecting the vascular areas of all the abdominal organs, but may also be produced through other vascular areas. The effect of the excitation of the skin is depending upon the extent of the area of the skin upon which the excitation is applied. Excitation upon a small area of the skin may not cause reflex action, whereas excitation of an extended area of the skin, even if it is superficial and slight, may produce a marked reflex action. Electric excitation upon trunks of the nerves to the skeletal muscles causes usually reflex depressor action. Even depressor action, as far as known, is chiefly affected by vasodilatation within the splanchnic area but also other vascular areas. Vascular reflexes may extend from one side of the body to the other.

In exhausted or moribund states (*adynamic agonium*) reflex depressor activity dominates. However, the author has observed in moribund asphyxic state (*asphyxic agonium*) *reflex pressor response to excitation of asphyxia blood even few hours before exitus* (16-17).

EXPLANATION OF THE TESTS, A, B, C AND D.

Test *a*. The requirement that a radialis-arteriotonometer must be so constructed that the compression of the artery is to be accomplished by means of a small pelotte, not larger than the palpation surface of the examiner's index finger is justified by the necessity of excluding from test *a* any and all mechanical devices by which excitation of skin or underlying structures might be produced of such extent as to evoke vascular reflexes in the moment of time at which the tension value is read. Therefore, the result of measurement of the radialis maximum tension by means of a radialis-arteriotonometer of competent construction is a *basic value* in that sense that it expresses the *actually* existing tension, *under physiological conditions,* not altered by the influence of vascular reflexes, whether pressor or depressor evoked at the time at which the reading of the tension value is made (17, 18, 19).

Tests *b* and *c* are so formulated that the reflex action evoked by light superficial mechanical stimulus (stroking), applied to an extended area of the skin, is obtained by test *b*, and by test *c* the reflex action of a pain-producing mechanical excitation limited to a small mass of the skin is obtained, both perceivable and measurable at radialis, for clinical purpose. In both tests, *b* and *c*, the mechanism is simplified by the proximity of the skin area stimulated to the posterior spinal nerve-roots through which the afferent nerves from point of excitation enter the cord, and the upper half of the cervical spinal marrow, whence the area stimulated derives its innervation; it is simplified also by the fact that the cutaneous area to which the mechanical excitation is applied, by experience referred to previously (page 6), is understood to be an anatomical structure sensitive to electric sympaticus reflex stimulation. (On the contrary, electric excitation of sixth, seventh and eighth cervical roots and first thoracic causes reflex depressor reaction.)

Test *d* is so formulated that thereby the reflex action produced by mechanical stimulation of a large nerve-trunk is made perceivable at radialis and measurable for clinical purpose. This test is reduced to simplest attainable terms by the fact that the ulnar nerve, at the point where the mechanical excitation is applied, is exposed superficially and accessible to pressure between the tip of the examiner's finger and the underlying bone without the intervention of other structures of marked excitability, that might otherwise have compromised the result. Simplicity is furthermore added to this test by the fact that by experience previously obtained it is a matter of record that electric stimulation of nerve trunks leading from brachial plexus causes reflex depressor action.

Tests *b*, *c* and *d*. It remains at this point to explain the reason for the rule given in Chapter II that in performing the tests *b*, *c* and *d* the renewed reading of the radialis maximum value, after applying the mechanical stimulus, should be made about 15 seconds after the moment of time when the stimulus is applied. The rule is so formulated because it is a physiological fact that in transformation of afferent influence in the bulb into vasomotor efferent influence the latent reaction period is estimated from two to seven seconds in man. According to personal observations of the author, the reflex vasomotor effect in some instances is volatile, speedily vanishing. In other instances, on the other hand, there is a more or less prolonged effect. The reading of the radialis maximum tension-value 15 to 30 seconds after applying the mechanical stimulus gives positive results always in test *d* (depressor), most often in tests *b* and *c* (pressor action). In such instances where no effect is perceived in tests *b* and *c*, it is possible that a volatile pressor effect has already vanished at the reading of the radialis maximum tension value. On the other hand, in such more rare instances where, through tests *b* and *c*, a depressor effect is obtained instead of the customary pressor action, the explanation is probable that the constrictor nerve and ganglia are exhausted as result of preceding prolonged continuous pressor activity in which case the pressor excitation is transformed into depressor effect. This last complication is made explicable by certain recent theories which cannot be discussed in this connection.

The possibility of exhaustion of the reflex excitability of the smooth muscle cells in tunica media of the arterioles is to be remembered in this connection as from this cause complications of the reactions may arise in asthenic states of prolonged diseases. (Acute diseases are not considered in this paper.)

IV. SPONTANEOUSLY STABLE VASCULAR TONUS AT A RADIALIS MAXIMUM TENSION EXCEEDING 140 MM., BUT NOT EXCEEDING 150 MM. HG.

Among the cases in Table I is one (No. 12) in which the basic value of the radialis maximum is 150 mm. Hg. and in whom the several tests, *b*, *c* and *d*, do not produce any reaction sufficient to alter this basic radialis maximum value. With these facts before one's eyes, it is a mere choice of a descriptive word to say that this case possesses a *stable radialis maximum value* compared with all the other cases in Table I which under influence of the same tests are subject to more or less *alteration of the radialis maximum value.*

This case (No. 12 in Table I) has been observed by the author during about eight months, part of the time every day for several months in succession. The radialis maximum value remained the same as indicated in Table I for successive days, only with the slight exception that some days test *d* produced a reaction sufficient to depress the value of radialis to 140 m.m. Hg. However, even with this slight modification under influence of an excitation which in all other cases produces alteration, it remains true that this case, No. 12, at the time indicated, possessed a stable radialis maximum value even when comparative measurements made on successive days were considered. Moreover, six months earlier in time, this case of a middle-aged man suffering from chronic bronchitis with nocturn asthmatic attacks had developed a radialis maximum resembling the one found in psychopathic persons of the same age, a tension oscillating between 220 and 250 mm. or more, with exacerbations related to the asthmatic attacks and remissions of tension during more quiescent periods. But, for the last two months of the period of observation, the patient had not had any asthmatic attacks and during those same months he had not had medical treatment of any kind. Thus, the character of the radialis maximum tension, at the time alluded to, is, in this case, an acquisition which is spontaneously retained. Described as above, this case illustrates the state of arterial tension which in this paper is alluded to under the denotation of "spontaneously stable vascular tonus at a radialis maximum tension of 150 mm. Hg."

In an earlier publication (20), the author has presented abundant facts in support of the conclusion that a spontaneously stable radialis maximum tension, exceeding 140 mm. Hg., but not exceeding 150 mm., is identical with the *normal arterial tension.*

Characteristics of the normal arterial tension. In presence of the facts referred to above, observed by the author *ab novo,* the nature of the spontaneously stable vasotonus, the normal arterial tension, appears to begin to be in some part perceivable. To say that Case No. 12 is characterized by absence of such perceivable pressor and depressor reactions as occur in all other cases in Table I, although true to fact, would not explain, describe or define the nature of the state of vasotonus which is now under consideration. The normal arterial tension cannot be adequately explained, described or defined by negative distinctions or formulations.

Just as the normal temperature of the body—formulable in exact thermometric terms—is the end result of the harmonious coöperation of innumerable mechanisms of the body and therefore defies attempts at adequate definition and description, so any attempt to describe or define the normal arterial tension must unavoidably fall short of adequacy because of the unsurveyable complexity of the mechanisms whose harmonious coöperation is the necessary prerequisite for attaining as end result the state of arterial tension which is formulable in exact arteriotonometric terms as indicated above.

At the present state of our knowledge the formula through which the normal arterial tension is expressed, *i.e.,* the radialis maximum tension spontaneously stable at a level of 150 mm. Hg., must be used, instead of definition, as the formula of identification, just as 98.6° Fahr. is the formula of identification through which the normal temperature is recognized even in the absence of an adequate definition. The description and explanation of the result contained in this formula of identification of the normal arterial tension must be left to complete itself gradually from the growth of knowledge on the subject, through continuous observation of facts, analysis of findings, and synthetic projections in the measure as such are sustainable. Thus the adequate definition will be gradually approached.

The distinguishing positive character of the radialis maximum tension in Case 12 in Table I is the *high grade of apparent resistance of the basic value of 150 mm. Hg.* This apparent resistance is a numerically perceivable expression of the *high grade of adaptability of the vasomotor mechanism* which enables it to adjust itself to variable influences from the environment, as represented by the tests, *b,* c, *d* and numerous others without loss of that reciprocal relation of constituent inner factors, *i.e.,* with undisturbed *coördination of vasomotor neurons* which expresses itself in the stable basic radialis maximum value of 150 mm. Hg., influences which in all the other cases in Table I produce disturbance in the preëxisting mutual balance of opposite pressor and depressor forces within the cardiovascular, neuromuscular mechanism. It must be very strongly emphasized, and it is hereby emphasized, that the normal arterial tension does not consist in loss of the natural reflex excitability, as might be inferred if normal arterial tension were described in terms of negation of pressor and depressor reactions in spite of such excitation as in other individuals brings out manifestations of pressor and depressor action. If the reflex excitability were lost, then a state of arterial tension were established which would be comparable with pupillary or patellar reflex-staleness, a pathological state of vascular reflex staleness; in a word, reflex angioplegia; which pathological state occurs in certain diseases as will be exemplified in a following chapter.

In view of that which has just been stated, the *normal arterial tension,* formulated in the continuously spontaneously stable vasotonus at a radialis maximum tension value exceeding 140 mm., but not exceeding 150 mm. Hg., may now be characterized as *a state of arterial tension in which the automatic and reflex excitability of the cardiovascular, neuromuscular mechanism possesses a high grade of coördination and adaptability to variable demands within wide limits, by force of which the basic radialis maximum value is balanced and retained undisturbed even though the reflex excitability is exposed to the influence of various pressor and depressor excitation.*

In a previous publication (20), the author has proven by abundant facts that the state of arterial tension which expresses itself through a spontaneously stable radialis maximum value exceeding 140 mm. Hg., but not exceeding 150 mm., coincides with non-existence of certain diseases or, in other words, that this same state of arterial tension coincides with high grade of natural immunity in relation to those certain diseases.

It follows that *a high grade of coördination and adaptability of the vascular automatic and reflex excitability to a wide range of variable demands resulting in a spontaneously stable vasotonus of normal radialis maximum tension value enters into the characteristics of high grade natural immunity.*

At this point the question presents itself whether this conclusion which is borne up by abundant facts, directly observed in nature, is also sustainable on theoretical grounds, or in other words, whether the state of spontaneously stable vasotonus as formulated and characterized above, explains or contributes to explaining, the fact of high grade natural immunity. Before entering upon this question, which must be reserved for a separate future communication, it is expedient to supplement the characteristics of the spontaneously stable vasotonus by further study of the reactions of the arterial tension. This will be done, to some extent, in the following chapters.

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FECAL UNITS AND INTESTINAL RATE, A BASIS FOR THE STUDY OF HEALTH AND INTESTINAL INDIGESTION.

BY FRANCIS LOWELL BURNETT, M.D., BOSTON.

(Concluded from page 376.)

INTESTINAL RATES.

These minor features undoubtedly have some significance in the action of the intestine on its contents; and the variations may be due in part to the great variety of food ingested by man, because the units of animals consuming very much the same kind of food day by day are much more uniform in size. But with man the variation is undoubtedly correlated to another factor; and that is intestinal rate. In this work intestinal rate means the shortest time in hours for a substance to pass through the alimentary tract, and a few estimates according to this definition may be cited. Paton says that food may remain in the intestine of ruminants for five days (120 hours[9]). Elliott and Barclay-Smith gave a rabbit some colored beads, which they first found in the dung in 24 hours. The observations on man vary considerably. Hertz, by means of the bismuth meal, says the time depends somewhat on the time of ingestion and defecation, and therefore gives a rate of from 9 to 32 hours.[10] Straus by using carmine gives 12 hours as the minimum rate and 47 as the maximum for normal limits.[11] And Case states that the colon should be emptied of barium by the thirty-sixth hour; but in what he calls a spastic colon some of the barium meal may be held in the proximal colon 50 hours after ingestion, as shown in Figure 14.[12] And Barclay[13] says "one sees so many instances of women in whom the opaque meal takes 48 hours or more to reach the rectum."

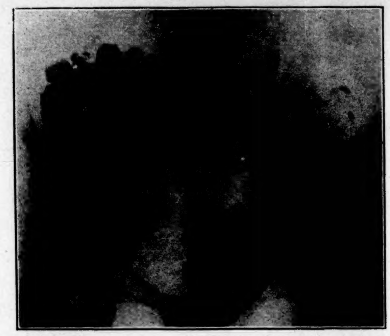

FIG. 13.—An x-ray photograph of the human colon after the ingestion of a barium meal. Note what appears to be a closure of Cannon's ring, by which the contents of the gut are held back in the proximal colon by waves of antiperistalsis, as in animals. (The print is used through the kindness of Dr. James T. Case, Battle Creek, Mich.)

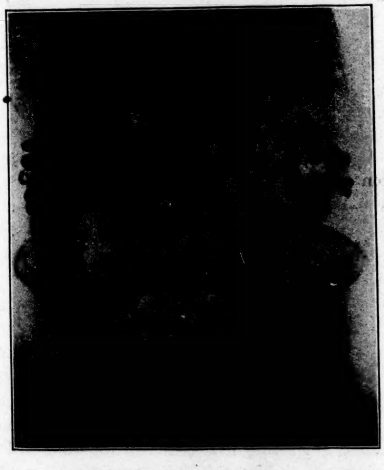

FIG. 14.—An x-ray photograph of the human colon 50 hours after the ingestion of a barium meal. Note the change in the contents at Cannon's ring, where the column of food is formed into small boluses (units) that are being carried through the distal colon as in animals. (The print is used through the kindness of Dr. James T. Case, Battle Creek, Mich.)

In the individual under observation, several substances have been used to determine the intestinal rate. In an attempt to make the estimates more accurate, a different substance was given after each of the three meals; that is, rape seed was taken at 8 A.M., charcoal at 2 P.M, and millet seed at 8 P.M.; but with a slow intestinal rate the three substances are so commingled in the feces that it is difficult, not to say impossible, to recognize any one of them before the others. Then, too, charcoal seemed at times to cause an unnatural retardation of the rate, so that for most of the tests millet seed alone was used. This seed is not unlike that of tomatoes and berries, foods that are frequently ingested; and it is readily recognized as white dots in the dark brown field of the feces (Figure 10). Of this a measure of 30 cc. was mixed with half a tumbler of water, and gulped down at 2 P.M., on a Tuesday for many weeks; then the stools at 10 A.M. and usually 3 P.M. on the following days were examined for the seed and the time noted when they were first apparent. In this way the following figures represent the number of hours intervening between the time the seed were taken and the time of their first appearance in the feces: 73, 85, 39, 44, 39, 61, 39, 61, 39, 49, 49, 44, 39, 73, 44, 39, 44, 68, 44, 50, 63, 39, 44, 68, 73, 68, 73, 25, 39, 68, 68, 44, 73, 73, 49, 68, 73, 20. To put these estimates in order according to the decimal in which they occurred would be as follows:

25, 20.
39, 39, 39, 39, 39, 39, 39.
44, 49, 49, 49, 44, 44, 44, 44, 44, 44, 49.
50, 56.
61, 61, 68, 63, 68, 68, 68, 68, 68, 68.
73, 73, 73, 73, 73, 73, 73.
85.

As the stools associated with a rate below 40 hours are not entirely composed of units (Figure 10), the rate appears to be abnormally rapid; and an average of the remaining estimates is 64 hours. This figure represents the time the seed were first seen; but they continue to be apparent in the feces for 120-144 hours (5-6 days) after the time of ingestion. And while it seems possible to get an estimate of the rate of an abnormally rapid dejection from a consideration of its character, it is also apparent that those entirely composed of units are a fairly accurate index of whether the mass represents food that was 80 hours, 40 hours or 60 hours, in its passage through the body. For a stool made up of units which separate on dejection, like Figure 7, represents a very slow intestinal rate; one like Figure 8 is associated with one that is more rapid, or 60 hours; and finally one composed of indefinite units (Figure 9) is found, with a rate that is somewhat more rapid. The rate for this individual of about 60 hours appears to be normal; for in a few subsequent dejections at a more rapid rate, the units not only vary in size, but many of them are undersized or immature. This point, however, is better illustrated after the dejection of a specimen showing an accelerated intestinal rate. Such a specimen is shown in Figure 10. The first portion is composed of well defined units of a regular size, in the intermediate portion they are indefinite, and at the end the mass containing most of the millet seed is foul and formless. This specimen represents a premeditated attack of intestinal indigestion (according to this definition). Millet seed were given at 2 P.M. on a Tuesday. At Wednesday's supper an excess of sugar in the form of syrup candy and jam was ingested, and on Thursday morning at 10 o'clock this large mass of feces was dejected. For a few days following, sweets were avoided, with the result that all of the food taken into the body was retained until Saturday morning at 10 o'clock, when the mass illustrated in Figure 11 was excreted. This stool is small, and while it is entirely composed of units, they are small and undersized. Such a sequence of events with these characteristic stools has been observed many times; accordingly, it seems that the gut at a slow or what appears to be the normal intestinal rate of about 60 hours contained a certain amount of aliment; but when the rate is accelerated and an excess of the intestinal contents is dejected, the gut afterward retains all of the food, if suitable, until it is normally replete, and then the additional amount is formed into units, passed along and dejected. In general, then, while the individual under study has an intestinal rate that varies somewhat, the stools associated with those above 40 hours are entirely composed of units, but the dejections at a slower rate of about 60 hours, are formed of units of a uniform size day after day.

THE MOTILITY OF THE HUMAN COLON.

The action of the human colon on its contents has not been observed directly as in animals; but the motility has been studied extensively by means of the bismuth meal and x-ray. In this way Case has made many observations, and he has divided the large gut into the same physiological parts that have been made for the lower animals; that is, the ring of Cannon in the transverse colon divides it into the proximal and the distal portions. He also states that his observations have almost to the minutest detail confirmed the work of Cannon on animals. The prevailing movement in the proximal colon is antiperistalsis, which consists of a movement of waves backward toward the caecum, as shown in Figure 13. In this illustration the column of food is seen to be held back by waves of antiperistalsis in the proximal colon, thus accentuating the constricting ring of Cannon. The characteristic activities in the distal colon are churning and onward movements. Haustral churning, the name given to one of the forms of motility, Case describes as segmentation, which is similar in many respects to the rhythmic segmentation in the small intestine. The onward movements, on the other hand, take place in two different forms; the mass movement of Holzknecht, by which a sausage-shaped mass travels along the gut with great rapidity, and the slow, propulsive movement of Fischl and Porges, by which "small boluses the size of a pigeon's egg travel slowly down the descending colon into the pelvic colon." The former movement is without analogy in the activities of the colon of animals, and may be abnormal; but the movement by which small boluses the size of a pigeon's egg travel down the descending colon seems to simulate in every respect the observations already described of animals, by which units formed in the intermediate colon are propelled onward through the distal colon by waves of peristalsis. Figure 14 graphically illustrates this activity. The food column is seen intact up to a point where Cannon's ring or the intermediate colon is likely to be; and from there onward it is broken up into units or small boluses which appear to be travelling down the distal colon. A point, however, of this figure that should be emphasized is that it was taken 50 hours after the ingestion of the barium meal. In other words, this picture portrays the colon with a slow intestinal rate, which Case describes as a spastic colon. In these cases, too, he finds the capacity of the proximal colon as measured by a barium meal, larger than normal; but the distal part of the gut has a smaller capacity. It is evident, therefore, that the action of the human colon may be even more complex than that of lower animals; and not only may the aliment be delayed in the proximal colon by a closure of the constricting ring and antiperistalsis, but along the distal colon the contents may also undergo haustral segmentation. Perhaps these processes mould or mark the intestinal contents so that the functions are recognized in the character of the feces; or is it possible that units are a sign of antiperistalsis, and the lines on them an indication of haustral segmentation? Yet, regardless of the result of these activities, they must serve some useful purpose, and it is difficult not to believe that they form a means to increase the amount of absorption and nutrition to be obtained from the food.

THE CHARACTER OF THE FECES AND DISEASE.

If the form and marks of a stool composed of units express some function of the intestine; then the great variation of the character of the human feces must be of even more significance. Such a variation makes a division difficult, for a single dejection may in part present points of one type and in part those of another; yet each one is predominantly typical, and may be so classified. For convenience in discussion, suppose there are three types; first, the semi-fluid and very foul stool of diarrhea; secondly, the foul and formless—a common dejection, and finally, one entirely composed of units. Diarrhea is an abnormal condition and is frequently due to the ingestion of improper food, and in one condition of disease is due to insufficient[14] mastication of the food. On the other hand, the continued dejection of fecal units appears to require care in the selection of food, and thorough comminution to prepare it for digestion. One has an intestinal rate of less than 20 hours, the other one of about 60; therefore the foul and formless type having characteristics between these extremes seems likely to be due in a lesser degree to some of the causes of diarrhea. But another point in the comparison is the odor. The offensiveness and stink of organic matter is generally an accurate index of decomposition or putrefaction. The odor of a semi-fluid stool is usually very offensive; that of the foul and formless is stinking; whereas that formed entirely of units is not disagreeable. Furthermore, in the investigation of a few individuals, Folin and Denis[15] have found that the phenols, which give the most accurate index of the degree of putrefaction of the intestinal contents, are increased in the feces in diarrhea and after the administration of laxatives or enemata. Therefore, the semi-fluid and the foul and formless stools are evidently associated with an excessive degree of putrefaction and decomposition, in comparison to one composed entirely of units. The final point in the comparison, however, is the most striking, and that is the relation between the form of the feces and disease. To look at the units dejected by the rodents (Figures 1 and 2) and consider their form, one is immediately impressed by their exact outlines and contours. Those of the guinea pig, for instance, are equally long, of the same circumference, and have very much the same outlines. Such exact forms must be the result of some natural action—some function; and as they represent the final moulding of the intestinal contents, they must also be an expression of the complete action of the intestine. And besides, as they are invariably dejected by this animal, these units of dung must be normal. The same may be said of the dung of the rabbit, the horse, the sheep, the pig, the monkey, and without doubt the dung of many animals not yet observed. Therefore, it is inconceivable to believe that feces entirely composed of units dejected by the highest type of animal or man, as shown in Figure 8, can bear a different interpretation. But in Figure 10 a dejection of a mixed type is illustrated. One part is formed of nicely divided masses, with evenly rounded contours and a smooth surface, whereas the other is composed of a solid mass without any marks or subdivisions and a rough surface. One portion bears the ear marks of a natural action, while the other appears abnormal. But if disease is defined as "any derangement of the vital functions in which their natural action is interrupted or disturbed, and causing or threatening pain and weakness, morbid or unhealthy condition; malady, distemper[16] or sickness," the foul and formless stool or, indeed, one illustrated in Figure 10, showing an interruption of one of the vital functions, is a sign of disease. And a definition given in Osler and McCrae[17] is peculiarly applicable to this condition. "In a broad sense, intestinal indigestion is a term denoting any form of interference with normal intestinal functions, but it is more properly restricted to functional derangements, rather than such as may attend organic disease." From these definitions the foul and formless stool, not only showing a disturbance of a natural action, but also—what appears to be a derangement of the normal intestinal functions—is an indication of disease, intestinal indigestion.

INTESTINAL INDIGESTION AND AUTO-INTOXICATION.

If fecal units serve as a sign in the determination of intestinal indigestion, it is interesting to consider the action of the gut in what may be the normal condition; and then what occurs in this disease. In this comparison it appears as if there were two contending forces in operation for the benefit of the individual; one, the normal, which tends to retard the intestinal rate, so that the intestinal contents pass through their complement of action and the body derives all of its proper nourishment, and the other, the abnormal, in which food incompatible with the bodily requirements or transformed into deleterious substances, is rapidly passed through the intestine at an increased intestinal rate, to prevent the body from extreme injury. Such a slowing of the intestinal rate is commonly thought of as an indication of stasis, stagnation of the intestinal contents, and auto-intoxication. Case, however, refutes such a conception, and says "that the terms, alimentary toxemia and intestinal stasis are not synonymous is self-evident. Some patients may show evident intestinal stasis without exhibiting any signs of toxemia. Other patients with only a slight stasis may be intensely toxic, while in still other patients with a high grade stasis, there may be only slight toxicity." In this way, too, it is perfectly evident that the use of oil or cathartics in those with an excessive putrefaction of the intestinal contents, will increase the rate and the elimination of the deleterious substances arising from this process, and probably alleviate some of the conditions of disease due to these poisons; but at the same time there will be a decrease in the amount of nourishment available. Intestinal indigestion due to foods incompatible with the bodily requirements appears to be due to the ingestion of an excess of sweets, fats or fruits or a combination of all three; in fact what may simply be called too much rich food. If this condition is acute according to the individual under study, there may be only vague abdominal pains probably due to gas; a loss of appetite and the customary relish for food; and, of course, irregular dejections for a day or two. And occasionally a head cold has followed in the course of three or four days after such a disturbance. On the other hand, it is difficult to guess at the effect on the body of the continued dejections of the foul and formless stool; unless it be a vague sense of weariness or exhaustion, headaches, and such indefinite symptoms. But when the food is transformed by excessive decomposition or putrefaction, autointoxication is likely to be the result; and the continued absorption of these poisons for a period of years or decades is supposed to cause a structural change in some of the cells of the body. Such a description is simply a brief review of the effects of this form of intestinal indigestion; and while it is primarily a disease of the alimentary tract and seems likely to be a factor in many of its disturbances, the loss of nourishment combined with the toxemia seems likely to give rise to as many diseased conditions as syphilis in its secondary and tertiary stages. Indeed, in an exhaustive study of autointoxication, Anders[18] considers that catarrhal colitis, dilatation of the stomach and enteroptosis are some of the disorders of the gastrointestinal tract supposed to be due to this form of food poisoning. Anemia, hypertension, and arteriosclerosis are some of the vascular conditions which suggest this cause; in faulty metabolism, as rheumatism, gout, diabetes, and obesity, some rather convincing evidence has been obtained; also asthma, emphysema, migrane, neuritis and neurasthenia are mentioned; and finally, lesions of the skin, as urticaria, eczema, and psioriasis seem to be due especially to the toxemia arising from the intestinal contents; and these factors acting separately or together may be the cause of many secondary conditions of disease. But this form of indigestion is readily recognized by the character of the stools, when fecal units are applied as a sign of health.

FECAL UNITS ARE ASSOCIATED WITH A HEALTH CONDITION OF THE BODY.

The food of man is so varied and of such a complex composition that acute attacks of intestinal indigestion are difficult to avoid occasionally; and these are graphically illustrated in the estimates below 40 hours in the series of intestinal rates previously reported. Only a few of the rates of 39, 25 and 20 hours were the outcome of forethought and were produced to confirm some point in the experiments. But to strive for health, the object should be dejections entirely composed of units day in and day out, year in and year out; and from the experience of the individuals studied, the habits to be formed are not very difficult to form and control. But the stool only must be the guide; and if on one day the intestinal rate appeared to be too rapid and a portion of the stool is composed in part of a foul and formless mass, the food considered responsible for the indigestion should be avoided; and in the course of a few days the rate will again become retarded and the stools composed entirely of good-sized units. Such a practice has been carried on by the individual under special study for a period of about ten years; and during this time only an unusual degree of well being has been experienced. The same may be said of the children, although the period of observation has been less than a year. Ordinarily, a stool composed of units is considered by many as a sign of constipation or even obstipation. But that this is not so with the individuals under study is shown by the fact that two movements a day are the rule, if the intestinal rate is sufficiently slow. And in view of a different conception of the action of the intestine, there should be a new conception of some of its disorders and especially constipation. This is because the normal intestinal rate and the character of the stool must be taken into account in every case; instead of holding to the inherited theory alone that it is normal and natural to defecate once a day, and if regularly performed all is well. Occasionally, however, in the man, there has been an abnormal retardation of the rate; and an enema was considered of value, but a laxative has never been found necessary. After an attack of indigestion there has been a loss of appetite and of the customary relish for food; but only for a short time, for when the rate became right again, both sensations returned. Nausea, belching, distress or fullness after meals, diarrhea, headaches, or a feeling of lassitude; in fact, none of the minor symptoms of ill health have been experienced. The sleep has been sound, refreshing, and free from dreams; and the weight of the body has remained constant within a few kilos, and a slight loss occurring during the summer being evidently due to an increase of muscular exercise. And the body has been capable of an unusual degree of physical and mental exertion. Accordingly, a few individuals on a basis of fecal units are unusually healthy. And if this form of stool is associated with a slow intestinal rate to complete the cycle of digestion, absorption and nutrition, a more critical study must be given to constipation, and the standard requirement of a daily evacuation looked upon with a less dogmatic and a more intelligent point of view.

FACTORS INFLUENCING THE FORMATION OF UNITS.

Units are formed in animals in the intermediate colon by the opening and closing of the constricting ring, as the pultaceous mass in the proximal colon is moved onward. A similar process seems likely to occur in man from an examination of the intestinal contents in Figure 14; but a closure of the ring, after the contents of the small intestine has been emptied into the proximal colon, appears to be the most essential factor. For if the ring remains open, the contents of the large intestine seem to be merely passed along rapidly by peristalsis and perhaps the mass movement of Holzknecht, and dejected in the foul and formless stool. But when the ring closes, antiperistalsis takes place; there is a delay in the passage of the aliment, discrete masses are formed, and dejected in a stool entirely composed of units. From what is known of the influences affecting intestinal motility in animals, the character of the food is undoubtedly a very essential consideration, and from the experience of the subject under study, this influence also seems to be the most important factor in closing the ring for a reverse passage of the contents in the proximal colon. While the food undoubtedly plays the most important part, the bacterial flora developing in the large intestine as a result of the character of the mixture, may have a secondary influence on the motility of the gut. The mixture entering into the proximal colon can be changed in several ways; thus the times of eating will affect it, the amount of food ingested will exert some influence, also the way the food is prepared for digestion and the proportion of the different elements will cause a change, and finally the number and time of emptying the bowel may have to be taken into account. These considerations have only to do with the habits of an individual; and those formed to elicit the complete action of the gut are entirely consistent with a simple and wholesome mode of living. Three meals should be sufficient for all adults, although a fourth meal four or five hours after the evening meal may occasionally be of value to induce sleep. But habitually eating between meals, as afternoon tea and refreshments in the evening, probably does more harm than good. At these times there should not be a demand on the body for nourishment and an excess of food is ingested. Only two meals a day may be of value for those that are excessively fat: one in the morning at 10 or 11, and another in the evening at 6 or 7. This practice, besides diminishing the amount of food ingested, forms a decided break in the habits of the individual, and is likely to be a factor in correcting other faulty ways of eating. The worst habit, perhaps, is eating too fast. By this fault, too much food is likely to be consumed; and as it is not properly prepared for digestion, it would seem as if the uncomminuted lumps not having been thoroughly mixed with, or protected by, the digestive juices, formed a favorable medium for a peculiar or excessive putrefaction within the intestine. This point is especially emphasized by McKenzie, who says, "the great importance of oral digestion is not sufficiently appreciated. Not only does the process of mastication in several subtle ways stimulate the digestive glands, but the juices from the mouth which are mixed with the food not only assist digestion, but prevent the flatulence which is so often a troublesome feature in the weakened digestion of heart failure."[19] Comminution of the food merely prepares it better for digestion; and this process is aided by prescribing a dry diet of crackers, toasted bread, and muffins, and cookies. But a carbohydrate diet, no matter how much it is chewed, is evidently insufficient for the entire requirements of the body; and a good proportion of animal protein seems essential. Support for this assertion not only shows the character of the teeth and alimentary tract of man to be omnivorous, but also physiologically; for if units are formed in the feces at all on a carbohydrate diet, they are small and indefinite. Although a good proportion of the essential foods is necessary, care must be exercised in the ingestion of rich foods; and an excess of sweets, fats and fruits, or foods having a tendency to unduly increase the intestinal rate, must be avoided. This point has been taken into account by pediatricians, in the treatment of the diarrhea of infancy; as the sugar is invariably eliminated in changing the formula. Fresh and cooked fruit, but without an excess of sugar, are of value in keeping the intestinal rate from becoming too slow. Observations on the coarse foods, such as the bran breads and many vegetables have been limited; but they do not seem to have an influence one way or another. Individuals vary in the amount of food consumed as well as the amount of nourishment necessary, consequently the amount of residue to be excreted will vary. Ordinarily, however, when the rate is sufficiently slow, two stools should be the rule every day; and these should take place at least half an hour after two of the meals, in order that the dejections represent the surplus of absorbable material to be removed from the gastrointestinal tract. The influence of muscular exercise on the formation of units and the intestinal rate is difficult to interpret; but in all probability the rate is increased by it. Such an observation is in accord with the condition of the dung of a horse after a long drive, when the dejections are frequent, soft, and formed of indefinite units. On the other hand, the loss of sleep seems to retard the rate. About eight hours sleep seems to be sufficient for an adult; and during the waking hours the mind should be properly exercised with an interest or work. Therefore, as it is possible to change the foul and formless dejections of intestinal indigestion to those entirely composed of units, the requirements necessary form the basis of treatment. Such a basis consists largely of correcting improper habits of eating; and those acquired merely conform to a sensible and wholesome mode of living.

CONCLUSION.

In animals, digestion and absorption are varied and complex processes. The food necessary for the proper nourishment of the body is delayed along its course in the stomach and proximal colon. But when the food is not suitable, it fails to bring into play the complete action of the gut; and as the carbohydrate meal in the stomach of a cat, it is rapidly passed on. In this way the stomach exhibits selective action; but the proximal colon appears to be even more sensitive to influences of this kind; and as its complete action is readily discerned in units formed in the dung, the normal digestion is readily distinguished from the abnormal. Similarly, in man the intestine has rates of motility and retardation, as well as periods of slow propulsive movement and discharge. Such complex acts must have some purpose; and it is difficult not to believe that they increase the amount of absorption and nutrition to be derived from the food. And their action seems to depend on the character of the mixture entering the proximal colon; for if the aliment is compatible with the needs of the body, it undergoes the complete mechanism of digestion; but if the mixture is too rich, if the proportion of the different elements is not right, and if it is not properly mixed and protected by the digestive juices, it will either be passed along rapidly and dejected, or decomposing, will also give rise to injurious substances. In one case, there is a reversed action of the gut and a retardation of its rate, after which the aliment is formed into units and excreted in the normal feces, and is a sign of health; but in the other, when the aliment is not in a suitable condition to be absorbed by the body, it fails to elicit some of the functions of the intestine, is discharged in the foul and formless stool, and is a sign of intestinal indigestion. Thus Nature, on the one hand, wise, makes a two-fold use of a portion of the gut to increase the animal economy; but on the other hand, beneficent, rapidly carries away substances that are incompatible or may be harmful to the body, and the health of the individual lies in the balance.

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THE ASSOCIATION FOR INTERNAL MEDICAL SERVICE will hold a meeting at Boston University (Room 22) corner of Boylston and Exeter Streets, Monday, April 25, 8.00 P.M. Dr. Horace Packard of Boston, recently returned from the Orient, will give an informal travel-talk, illustrated by stereopticon. The public is invited. ANITA S. WARD, *Secretary.*

MEDICAL REGISTRATION IN MASSACHUSETTS

The following table shows the results of the March examination of applicants for medical registration in Massachusetts:

MEDICAL SCHOOL ISSUING DEGREE	* NUMBER APPLYING	REJECTED	APPROVED
College of Physicians and Surgeons, Boston	4	4	
Mass. College of Osteopathy	3	3	
American College of Osteopathy, Kirksville, Mo.	2	2	
Middlesex College of Medicine and Surgery	8	6	2
University of West Tennessee	1	1	
Baltimore Medical College	1	1	
Emory University Medical School, Ga.	1	1	
Hahneman College of the Pacific	1	1	
Laval	1	1	
Columbia	2		2
Johns Hopkins	1		1
Maryland Medical	1		1
University of Maryland	1	1	
Imperial University of Russia	1	1	
University of Helsingfors	1	1	
Tufts Medical School	2	2	
Syrian Protestant Medical College	2		2
Rush Medical College	1		1
French Medical School Beyrout	1		1
University of Constantinople	1	1	
Harvard Medical School	1		1
University of Naples	1	1	
University of Lisbon	1*		
American Medical Missionary College	1		1
Jefferson, Phila.	1		1
Edinburgh University	1		1
Kansas University	1		1

* Result not determined.

◆

MEDICAL EDUCATION BILLS NOT ADOPTED.—It is disappointing to report that the bills relating to medical education, endorsed by the joint legislative committee of the Massachusetts Medical and Homeopathic Medical Societies, have been adversely acted upon by the Legislature. One provided for a pre-medical education equivalent to two years in a college of liberal arts, and the other for service as an interne before applying for registration. The bill giving authority to the Board of Registration to secure expert assistants in conducting examinations, is in a fair way to be enacted into law, but the provision of paying for such assistants was stricken out. This may render the bill impotent, unless appropriation may be secured through the supplementary budget.

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THURSDAY, APRIL 21, 1921

Published by The Massachusetts Medical Society under the jurisdiction of the following-named committee:

For three years HOMER GAGE, M.D., *Chairman*
EDWARD C. STREETER, M.D.
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For two years WILLIAM H. ROBEY, JR., M.D.
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THE MASSACHUSETTS MEDICAL SOCIETY ASSUMES OWNERSHIP OF THE JOURNAL.

WITH this issue, the BOSTON MEDICAL AND SURGICAL JOURNAL enters upon another cycle in its history. It is now owned by the Massachusetts Medical Society. Delay in assuming the management was due to lack of authority in the charter. An amendement has recently been authorized by the Legislature and the enabling bill has been signed by the Governor.

The purpose of the advocates of this new function of the Society was to endow the JOURNAL with the authority of this influential society. In adopting the recommendations of the proponents of this measure, the Council endorsed the ambitions of those who, having feared the gradual overshadowing of medical publications in this section of the country by larger periodicals, hold to the belief that a New England medical journal, maintained by New England energy and acumen, may have influence on medical progress. The quality of work done by master minds in New England will continue to have avenues through which the profession may be conveniently reached. The history of the JOURNAL is creditable, for it has reflected the unselfish interest of public spirited persons and able contributors, who have maintained it for many years. But because of the probability of interesting groups of men, willing to carry the burden indefinitely seemed so doubtful, careful consideration led to the conviction that a medical society could properly take on the functions of insuring the continuance of this publication. It is recognized that some members of the Society may feel that the financial burden may be considerable. To this objection, the answer may be made that the Society is more than a medical club. It was founded on the principles that, "Health is essentially necessary to the happiness of society," that "its preservation or recovery are closely connected with the knowledge of the animal economy and of the properties and effects of medicine," and that, "the benefit of medical institutions founded on liberal principles is universally acknowledged," hence the main purpose of the Society should be to promote the preservation and recovery of the health of the people. The social features are incidental and a means to an end, so that the Society may properly strive in the broadest way to bring the achievements of medicine to the attention of all practitioners and disseminate knowledge of the facilities of hospitals for instruction of students, as well as treatment of the sick. In addition to matters of interest in daily routine, there must always be up for discussion questions relating to legislation and ethics affecting the profession and the people. To meet these various problems, a local periodical, managed by those in touch with local conditions, is a necessity. If there be objection to this plan of society ownership of a journal, one may ask the critic to imagine the conditions that would probably exist if there should be no literature representing New England medicine. One may safely assert that there would be less and less of community interest. The profession would be more inclined to divide itself into cliques with lack of confidence in and coöperation with one another, and hence a degree of stimulating influence and honorable competition would be lost. This section would become provincial in thought and practice, except for a comparatively small group of progressive men who would find congenial associations in the larger cities. If these possibilities are to be avoided and the Society is to fulfill its mission, it must not only maintain a journal, but it must make that journal a power.

Every member has a definite responsibility. The JOURNAL will express opinions, not in a dogmatic way, but rather with the intent that questions of policy and professional activity may have careful consideration and judicial treatment.

The assistance of every member of the Society is cordially solicited. With this coöperation, the committee in charge has faith in the future of the JOURNAL.

(Quotations from the Charter of the Society.)

THE COMING EXAMINATION BY THE NATIONAL BOARD OF MEDICAL EXAMINERS.

THE National Board of Medical Examiners will hold its first examination in Boston, June 14 to 21, as announced elsewhere in this issue of the JOURNAL. This event should be of special interest to the recent graduates in medicine in this vicinity. The certificate granted by the Board to successful candidates is accepted by Army, Navy, and Public Health Service in place of the professional entrance examination for these services; it is accepted officially by medical examining boards of twenty states in place of their own professional examination; it is practically so accepted in a dozen other states, including Massachusetts, which are legally obliged to hold some form of examination for licensure; it is accepted as qualification for admittance to the Graduate School of the University of Minnesota, including the Mayo Foundation; and the Conjoint Examining Board of England and the Triplicate Examining Board of Scotland have recently granted the greatest recognition legally possible to them,—admission to their final practical examinations. It is confidently expected that in the near future, this certificate will be accepted as evidence of qualification to practise medicine by all licensing bodies in the United States and Canada. Aside from its relation to licensure to practise medicine, the certificate of the National Board of Medical Examiners is receiving growing recognition as evidence that its possessor is especially well trained in the science of medicine—a distinction which will have an increasing importance in the future. This will, perhaps, be its greatest value and should be an incentive to all qualified graduates to apply for examination.

An additional reason for trying this particular examination is the fact that it will be the last examination held under the present plan, with no fee except the nominal charge of five dollars for registration. After this examination, the National Board will inaugurate a new plan, which subdivides the examination into three parts, and, as this work must be placed upon a self-supporting basis, a total fee of one hundred dollars will be required for the whole examination,—twenty-five dollars each for Parts I and II, and fifty dollars for Part III, the final practical examination.

It has been the experience of the Board in inaugurating its examination in a new place, that many eligible physicians hesitate to take the examination, because of the requirement of laboratory examinations in the fundamental medical sciences,—apparently expecting the same kind of examination that would be given to students who had just completed these courses. It is believed that anxiety on this point is not warranted in the case of the recent graduates from good medical schools, since it is the aim of the Board to test the training of candidates in these subjects chiefly on topics which have a practical application in the practice of scientific medicine. Those who feel inclined to defer examination for a better opportunity to brush up, may well consider the contemplated increase in the fee, and the fact that a candidate entering the examination under the present plan is entitled, if he fails in this examination, to a second examination after the lapse of one year, on the payment of the registration fee of five dollars.

Eligibility for examination may be established on the basis of a four-year high-school course: two years of acceptable college work, including physics, chemistry, biology, and a modern foreign language; graduation from a Class A medical school; and one year as interne in an acceptable hospital or laboratory. Under the present ruling of the National Board, candidates are accepted after nine months of interne service, and applications will be received and given consideration after six months of interne service. In the case of candidates accepted before the completion of one year of interne service, the certificate will be withheld until the Board receives evidence of the satisfactory fulfilment of this requirement.

NON-RESIDENT MEMBERS OF THE MASSACHUSETTS MEDICAL SOCIETY.

THE Treasurer of the Society has called attention to a serious problem relating to the annual dues. There are members of the Society now living in places remote from New England, who have no opportunity of participating in the affairs of this section and yet, because of early association, desire to retain membership. Such members properly feel that the large dues which only carry the privilege of having the JOURNAL, are burdensome. An amendment to the by-laws might be adopted which would permit those who cannot attend meetings because of living at a distance, to retain a form of membership which would insure receipt of the JOURNAL.

The attention of the Committee on membership and Finance is respectfully called to this suggestion.

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MALPRACTICE LIABILITY INSURANCE RATES ADVANCED.

A CIRCULAR letter, distributed by the Ætna Life Insurance Company, gives notice that premium rates on physicians' and surgeons' Malpractice Liability Insurance are to be increased about 300 per cent, owing to the large number of claims and losses to the companies.

In the Middlesex South District Medical Society, a large number of physicians have taken out insurance. This is surprising in view of the fact that the Massachusetts Medical Society has provided for the defence of malpractice suits, and the records show that the results are favorable as compared with actions defended by commercial insurance companies. It is a well-known fact that lawyers are more successful in trials where the prosecution is directed against a corporation which must pay the amount awarded by a jury.

The Ætna Company has been selling group insurance at $13.50 per person. Under individual policies the rate, after April 1, will be $45. The group rate will be increased to $40. There have been verdicts rendered against physicians recently which have seemed to stimulate people to enter suits against physicians.

The function of the Society in defending these suits may be studied to advantage by the members. It is possible that the provision whereby the Society defends suits may not be generally known. It may be that physicians prefer to pay for insurance in order that the award of the jury, if any, be met by the insurance company, for the Society does not pay assessed damages.

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MEDICAL NOTES.

THE NATIONAL HEALTH COUNCIL.—The National Health Council met in Washington last week. Brigadier-General Sawyer attended a conference for the consideration of the extension of health measures by the Government. Dr. Donald B. Armstrong, Executive Secretary of the Council, and Dr. Sawyer later conferred with President Harding. It is expected that there will be interesting developments.

THE ANNUAL MEETING OF THE HOMEOPATHIC SOCIETY.—The eighty-first annual meeting of the Massachusetts Homeopathic Medical Society was held in Boston, April 13, 1921. The papers presented were as follows: "An Interesting Case of Laryngeal Tuberculosis," with two illustrations, by George B. Rice, M.D.; "The Uterus and the Menopause," by DeWitt G. Wilcox, M.D.; "Diagnosis and Prognosis of Hemorrhage during Pregnancy," by E. P. Ruggles, M.D. Surgical operations and clinical exercises were conducted at the Massachusetts Homeopathic Hospital, and luncheon was served at the Hospital.

The business session occupied the afternoon, and the annual dinner occurred at Young's Hotel in the evening. Addresses were given by Dr. Alfred Worcester, Dr. Channing Frothingham, Dr. W. P. Bowers, and President L. H. Merlin. Dr. Worcester's theme was based on the necessity for more nurses, and during his remarks, attention was called to the work of the Commission appointed to study the question of maternity and infant welfare, emphasis being given to the value of nursing work in the prevention of mortality and morbidity in midwifery and among infants. In an interesting way, the development of pregnancy clinics and visiting nursing associations was forcefully described, and the benefits of these forms of social service explained. The explanation for the shortage of nurses seemed, to this speaker, to be in the failure to properly care for nurses on private duty work, in that the demands were too exacting, and hence physicians and older nurses advised young women not to enter the profession.

Dr. Frothingham clearly and logically argued for the better preparation of practitioners, by requiring a reasonable pre-medical course and also an interne year in hospitals equipped for teaching. He reviewed the work done by the committee on medical education in presenting bills to the legislature, argued that the injustice of allowing young people to enter medical schools which do not fit students to become qualified practitioners should be done away with, and showed that Massachusetts now endorses three low-grade medical schools, whereas the country at large has almost eliminated this type of medical schools.

Dr. Bowers gave a brief history of the Boston Medical and Surgical Journal, and announced that the Massachusetts Medical Society has bought the Journal with the intention of making it representative of New England, as well as local medical activities. To this end, the coöperation of the Massachusetts Homeopathic Medical Society is sought.

President Merlin explained that, having come from Kansas, he found that it requires time to adjust one's self to Boston habits and traditions, but that now he was so happy in his work and associations, that he was not desirous of going to heaven any more than the Sunday School child whose answer furnished the text for his remarks. He showed that the Boston University Medical School has entered upon a plan of development in harmony with the progressive and scientific spirit shown in the past.

The officers for the ensuing year are: President, Charles T. Howard, M.D.; First Vice-President, Edgar A. Fisher, M.D.; Second Vice-President, Nelson M. Wood, M.D.; Recording Secretary, Nathan H. Garrick, M.D.; Corresponding Secretary, David L. Belding, M.D.; Treasurer, Milo C. Green, M.D.; Chairman Board of Censors, George N. Lapham, M.D.

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EXAMINATION BY THE NATIONAL BOARD OF MEDICAL EXAMINERS.

The National Board of Medical Examiners will hold an examination in Boston, June 14 to 21, inclusive.

Subjects: Anatomy, Clinical Physiology, Physiological Chemistry, Pathology, Bacteriology, Materia Medica and Therapeutic Medicine, Surgery, Obstetrics and Gynecology, Hygiene and Sanitation. The certificate of the National Board is accepted as equivalent to a professional examination by the Federal Services and a large majority of State Medical Examining Boards.

Eligibility for examination: A four-year high school course, two years of acceptable college work, including physics, chemistry, biology and a modern foreign language; graduation from a Class A medical school, and one year as interne in an acceptable hospital or laboratory; application for examination will be considered from interne who had completed at least six months of interne service.

Applications should be made before May 25, to allow for proper investigation of credentials.

Information and application forms may be obtained from Dr. Horace D. Arnold, 520 Commonwealth Avenue, Boston. Dr. Arnold may be seen at his office from 4 to 5, Mondays, Wednesdays and Fridays, until May 25, or by appointment.

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SOCIETY NOTICES

New England Ophthalmological Society.—The next meeting of the Society will be held at the Massachusetts Charitable Eye and Ear Infirmary, 233 Charles Street, Boston, on Tuesday evening, April 26, 1921, at eight o'clock.

Hospital Cases: Cases of dacryocyst-rhinostomy. Separation of the retina treated by electrolytic punctures. Demonstration of foreign body spud illuminator. Dr. W. Holbrook Lowell, Boston.

Case Reports: "Primary Sarcoma of the Cornea, with Report of a Case," Dr. George S. Derby, Boston; "Unusual Case of Retrobulbar Neuritis," Dr. Joseph L. Dowling, Providence; "Recurring Polypoid Granulation Due to Foreign Body in Eyelid," Dr. J. H Doyle (by invitation); "Case of Embolism of the Retinal Arteries," Dr. H. B. Riemer (by invitation); "Glioma Retinae Treated by X-rays with Apparent Success. Period of Observation, Three Years," Dr. F. H. Verhoeff, Boston. W. Holbrook Lowell, *Sec*

New England Association for Physical Therapeutics.—There will be a meeting of the New England Association for Physical Therapeutics on Tuesday, April 26, 1921, at eight o'clock at the Hotel Victoria, 271 Dartmouth Street, Boston, Mass.

Dr. H. C. Westervelt of Pittsburgh, Pa., will speak on "Physiotherapy in Military and Civil Practice," illustrated.

Dinner in the grill room at 6.30 p.m.

Dr. Louis B. Hayden, *Secretary*.

Worcester District Medical Society.—The regular meeting of the Worcester District Medical Society was held in the Out-Patient Building of the Worcester City Hospital, April 13, 1921. The following papers were read: (1) "Cancer of the Appendix, with Report of a Case," Dr. C. J. Byrne; (2) Routine Treatment of Prostatism," Dr. W. B. Bieberback; (3) "Interpretation of Some Electro-cardiograms," Dr. G. M. Albee; (4) "Routine Surgical Trettment of Thyroids," Dr. R. P. Watkins; (5) "Report of Three Hundred Cases from the Standpoint of Blood Chemistry," Dr. E. B. Bigelow; (6) "Loose Bodies in the Knee-joint," Dr. F. W. George; (7) "The Hospital as a Diagnostic Centre," Dr. E. L. Hunt; (8) "Review of Some Cases of Calculi of the G. U. Tract, Illustrated by Lantern Slides," Dr. O. D. Phelps.

The course of lectures given by Dr. Frederick T. Lord of Boston, under the auspices of the Worcester Extension Course of the Harvard Extension Graduate School of Medicine, has been so extensively subscribed that three or four extra lectures will be added to those already announced. Fifty-five medical men from Worcester and vicinity are taking the course.

Dr. Charles A. Drew, Superintendent of the Worcester City Hospital, is making a satisfactory recovery from a slight fracture of the skull. While at tending a dinner of the Dartmouth College Club, he was taken with an attack of vertigo, and fell, heavily striking a table. It is expected that he will be able to take up his duties in the course of two or three weeks.